

What is claimed is:

1 1. A method of detecting missing parts in a workpiece comprising a plurality of parts,
2 comprising the steps of:

3 a) moving the workpiece relative to a bar code reader;

4 b) detecting a line image across the workpiece with the bar code reader,
5 producing a signal output representative of the line image;

6 c) deriving a processed signal from the signal output of the bar code reader;

7 d) comparing the processed signal to a reference representing a workpiece
8 without missing parts; and

9 e) indicating if the processed signal does not match the reference.

1 2. The method of claim 1, in which the workpiece is a parallel-link chain, and the missing
2 part is a link in the chain.

1 3. The method of claim 1, in which the workpiece is a plurality of parts in a container.

1 4. The method of claim 1, in which the deriving step (c) comprises the steps of amplifying
2 an output from the bar code reader and filtering the amplified output.

1 5. The method of claim 1, in which the deriving step (c) further comprises the step of
2 extracting a portion of the signal output representing a part of the line image,
3 forming a data analysis window, and the comparison step (d) is performed only on
4 the portion of the image in the data analysis window.

1 6. The method of claim 5, further comprising the step of providing scannable indicia on at
2 least one side of the workpiece, in position to be imaged by the bar code reader
3 along with the line image of the workpiece, and the step of extracting uses the
4 imaged scannable indicia as a marker to determine the data analysis window.

1 7. The method of claim 6, in which the scannable indicia are bar codes.

- 1 8. The method of claim 6, in which scannable indicia are provided on each end of the
2 workpiece, and the data analysis window is taken between the detected scannable
3 indicia.
- 1 9. The method of claim 1, in which the step of deriving a processed signal comprises
2 producing an integral signal level representing an average level of the signal output
3 of the bar code reader, and the step of comparing comprises comparing the integral
4 signal level to a reference signal level.
- 1 10. The method of claim 1, in which the step of deriving a processed signal comprises
2 converting the signal output of the bar code reader into a number.
- 1 11. The method of claim 10, in which the reference is a number, and the step of comparing
2 comprises comparing the two numbers.
- 1 12. The method of claim 10, in which the number is derived by counting level transitions
2 in the output of the bar code reader across the linear image.
- 1 13. The method of claim 10, in which the number is a binary number in which each bit
2 represents a detection or non-detection of a part.
- 1 14. The method of claim 1, further comprising the step, before the detecting step (b) of
2 illuminating the workpiece.
- 1 15. The method of claim 14, in which the workpiece is illuminated so that light reflects off
2 the workpiece, and the linear image is produced from a reflected light image of the
3 workpiece.
- 1 16. The method of claim 14, in which the workpiece is illuminated from behind, such that
2 the workpiece is between the illumination and the bar code reader, and the linear
3 image is produced by the parts blocking light from the illumination.
- 1 17. The method of claim 1, in which the workpiece is moved continuously relative to the
2 reader.

1 18. The method of claim 1, in which the workpiece is moved in a start-stop motion relative
2 to the reader, and the line image is detected while the workpiece is stationary.

1 19. A missing part detection system for detection of missing parts in a workpiece having a
2 plurality of parts, comprising:

3 a) a light source for illuminating the workpiece; and

4 *Sub* b) a light sensitive array for detecting a line image of the workpiece,
5 *A2* produced by said light source, having a signal output representative
6 of the detected line image; and

7 c) a signal processing circuit having an input coupled to the signal output of
8 the light sensitive array, and an output, such that the signal output of
9 the light sensitive array is compared to a reference representative of
10 a complete workpiece without missing parts, and the output of the
11 signal processing circuit producing a signal when the comparison
12 indicates a part is missing.

1 20. The missing part detector system of claim 19, wherein the light sensitive array forms a
2 bar code reader.

1 21. The missing part detector system of claim 18, in which the workpiece is a parallel-link
2 *Sub* chain, the missing parts are links in the chain, and there are two bar code readers,
3 *A2* one each to scan guide row and non-guide row links of a chain.

1 22. The missing part detector system of claim 21, further comprising a chain guide having
2 vertical slots slightly wider than the chain, through which said bar code readers
3 scans said chain links.

1 23. The missing part detector system of claim 22, wherein an inside of chain guide is
2 painted black to minimize background reflections.

1 24. The missing part detector system of claim 19, wherein the workpiece is positioned
2 within a depth-of-field for said light-sensitive array.

1 25. The missing part detector system of claim 19, wherein the signal processing circuit
2 comprises a high pass filter and adjustable trigger level pre-amp.

1 26. The missing part detector system of claim 19, wherein the signal processing circuit
2 *sub* utilizes mathematical integration of an output signal from said diode array and
3 *Q* calculates an area under a measured output curve, and the reference is a voltage.

1 27. The missing part detector system of claim 19, wherein the signal processing circuit
2 counts a number of level transitions in the signal output of the light sensitive array,
3 and the reference is a preset value.

1 28. The missing part detector system of claim 27, wherein the signal processing circuit
2 includes a variable analysis window that only counts changes within said analysis
3 window, such that signals outside the window are ignored by said analysis system.

1 29. The missing part detector system of claim 19, in which the light source is located so
2 that the workpiece is illuminated from a same side as the light sensitive array, such
3 that the line image is detected by reflection of light from the workpiece.

1 30. The missing part detector system of claim 19, in which the light source is located
2 behind the workpiece, such that the light from the light source silhouettes the
3 workpiece, and the line image is detected by light blocked by parts or passed where
4 there are no parts.